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INTERCOLONIAL RAILWAY.

General Instructions (No. 2.)

To The Engineering Staff.

It is important that a uniform system be adopted in staking out the work, making measurements, entering field notes, preparing and preserving exact records of every thing done. The undersigned, therefore, requests that the following instructions shall be carried into effect:—

1. For the purpose of measurement and record the Line of Railway will be considered as running Easterly and Westerly, and that side of it nearest the River St. Lawrence, Bay Chaleur, and the Gulf of St. Lawrence, will invariably be considered and designated "The North Side." The opposite and inland side "The South Side."

The Cardinal Points.

2. All Profiles or Longitudinal Sections will be plotted so as to face the South, thus placing the Westerly end at the left hand, and the Easterly end at the right hand.

Profiles.

3. All Cross Sections will be plotted to face the West. The measurements north of the Centre Line will be *left*, those south of the Centre Line *right*.

Cross Sections.

4. All Field Notes must be clearly and distinctly made in pencil, copies will be made in ink; but the original notes must on no account be inked or changed in any way, only reduced levels or other figures calculated in the office, should be entered *in ink* in field books. Field books should contain the name of the person by whom the measurements and notes are made. He will invariably accompany the notes with ample explanations, so that any other Engineer could easily find the locality, and understand the whole at

Field notes.

a glance. The dates on which the measurements are made should also be entered.

Datum
Levels.

5. The same general Datum should be carried throughout the whole Line; but as this may at present be found impracticable or inconvenient, each District Engineer will only be required to see that a uniform Datum is adopted on the several Divisions of the work within his District. When the levels meet at the ends of Districts, the exact differences will be ascertained, and placed on record.

6. The first duty of the Division Engineer will be to establish, with perfect accuracy, Bench Marks and Reference Stakes throughout the Contract under his immediate charge.

Bench
Marks.

7. Bench Marks should be established about every 1000 feet, and always at the two-ends of heavy cuttings, for easy reference; and positions should be selected for them so that they will not be destroyed in the clearing of the Railway lands. They should be numbered consecutively on each contract, and their numbers and heights above datum distinctly and permanently marked thereon with blue paint, and on timber with a cooper's-marking tool. Where the line does not pass through timbered land, and no suitable object can be had convenient to the work for Bench Marks, substantial posts must be sunk in the ground at least 5 feet, and completely prevented from being raised by the frost.

Reference
Stakes.

8. Reference Stakes should be placed at least at the beginning and end of each curve, and on tangents at every 20 chains; their object is to facilitate the finding of the centre line in the event of the stakes being destroyed by fire or otherwise. They should be placed at an angle of 45° to the line of tangents, and at even distances of say 100 feet from the centre stake, at the intersection of diagonal lines connecting them, as in Fig. 1. Where the Railway runs along the edge of a River, or for any other reason, Reference Stakes can only be placed at one side of the line; they should be driven as shown in Fig. 2: the intermediate Stakes being placed exactly at right angles with the centre line, and respectively 30, 60, and 100 feet from it.

Fig. 2.

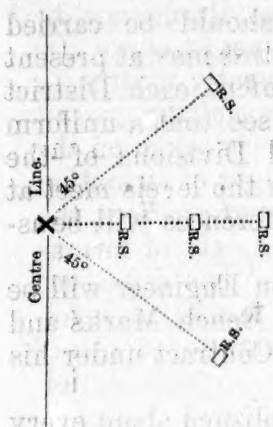
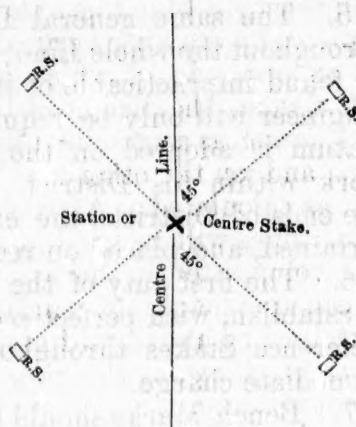


Fig. 1.



9. Plugs 3 inches diameter and 12 inches long should be driven level with the surface ground at the foot of all Reference Stakes, and a nail in the head of each Plug should show the exact horizontal distance intended from the Centre Stake. All Centre Stakes and Reference Stakes should have their tops painted blue in order that they may readily be distinguished.

Reference
Plugs.

10. Tables of Bench Marks and Reference Stakes, describing exactly their position and in the case of the former giving their numbers and elevation above the general Datum of the District, must be made out, and copies filed in the Division and District Offices. The position, numbers, and height of Bench Marks, should also be entered on the working profiles at the nearest station points.

Tables of B.
M. & R. S.

11. So soon as the Centre Line has been carefully defined on the ground, and Reference and Bench Marks established, in accordance with the above instructions, it will be the duty of the Engineer in charge to make a longitudinal Section or working Profile, to accomplish which with accuracy a "Plug" must be driven at the foot of and immediately in front of each centre stake (or station). The Plug will be made level with the surface of the ground, and upon it the leveling rod must be held when levels are taken.

Working
Profiles.

12. The working Profile will be made on drawing paper to a scale of 200 feet horizontal, and 20 feet

Working
Profiles.

vertical. The gradients will be drawn with great care by the District Engineer, and, after being approved by the Chief Engineer, and finally adopted, they will be shown by a blue line; the working Profile will be completed by drawing vertical pink lines at every 100 feet, on one side of which will be neatly written in black figures the height of the surface of the ground above *datum*, as ascertained by the levels taken on the Plugs, and on the other side the height of formation level, as calculated. At each *change of gradient*, the vertical lines will be in blue, and the height of formation level written in the same color. The difference between the height of surface and formation level, ascertained as above, will give the height or depth of *cutting* or *filling*, as the case may be, at each Station or Centre Stake.

Centre
Stakes.

13. Each Centre Stake, which will have the distance marked thereon, according to the actual chaining thus, 304, must also have distinctly marked on the opposite side the height or depth of the Plug above or below formation level, to indicate the depth of cutting or height of filling; thus, Cut 10.05 or Fill 4.79.

Cross Sec's

14. The next proceeding will be to make Cross Sections. These will be taken at least at every 100 feet Station, whether in cuttings or embankments, and also at a sufficient number of intermediate points, wherever a change in the ground takes place, so as to insure a perfectly accurate record of the various inequalities of the original surface.

15. At these intermediate points Centre Stakes will be driven, and the chaining marked thereon; one side thus, 304+27; and on the other side, the cutting or filling as the case may be; thus Cut 40.60 or Fill 7.80.

Cross Sec'n
Lines.

16. The lines of the Cross-Sections must be set out exactly at right angles to the centre line on tangents; and on curved portions at right angles to the tangent of the curve. These lines must be determined by instrumental means (say by a cross staff with a line of sights at least eight inches long.) Two stakes will be driven on each side of the centre line, one at 30 feet and the other at 60 feet, measured very carefully, on a horizontal line. In very deep cuttings or high em-

bankments another stake at 90 feet or more may be put in. These will serve to define the line of Cross Sections and be useful for future reference, should the centre stakes be removed. The numbers of the centre stakes should be marked on the west side of the 60 feet stakes, and the distance from the centre line should be marked on all the stakes on the sides facing the centre line.

Cross
Section
Stakes.

17. The levels on these Cross Sections should be taken in the same manner as those on the longitudinal line, always commencing on a Bench Mark, and using the same Datum, the levels should be continued through a series of Cross Sections (taking care to enter the number of station and distance from centre line, north or south, opposite each point taken), till another Bench Mark is reached, on which a level must be taken to test the accuracy of the whole series, and so on to the next Bench Mark.

Levels.

18. In all Cross Sections a level should be taken on each side of centre line, immediately under or over the edge of road bed, to facilitate the calculations of areas; that is to say, if the base of cuttings be 30 feet and embankments 18 feet, levels should be taken at 15 feet from the centre line, in the one case, and nine feet in the other. Levels should also be taken at every point where there is a sudden change in the surface of the ground.

19. When these field operations are completed, the Datum of each Cross Section will be reduced to *formation level* on the Centre line at the point where each Cross Section is taken; and the relative heights of all points on the Cross Section, above or below this level, will be computed, and entered, together with the distances from the Centre Line, in a Book (form No. 3) prepared for that purpose, and of which an example is here given. In some cases it may be more convenient to take the levels for Cross Sections from the Plugs driven on the centre line; but in every instance they must be reduced to *formation level as a Datum*, and so recorded in Book No. 3. All distances must be made on horizontal lines, and measurements and calculations of every kind must be made with as much accuracy as possible.

Datum of
Cross Sec's.

Section
Book.

Centre Line assumed to extend from West to East, and Cross Sections from North to South. Formation Level at intersections is the Datum of each Cross Section.

Distance or Station.	Station. 201	Station. 202	Station. 203	Station. 203+50	Station. 293+75
Change of Gradient or rise per 100 feet.	Level.	Level.	Change.	1 per 100.	1 per 100.
Surface.	393.25	393.60	394.00	393.55	392.25
Formation....	393.00	393.00	392.00	392.50	392.25
Cutting.	0.25	0.60	1.00	1.05
Filling.....
<p>NORTH OF CENTRE LINE.</p> <p>CROSS SECTIONS.</p> <p>SOUTH OF CENTRE LINE.</p>				30 -8.00	40 -18.00
		30 +5.50	30 +0.20	(18) -6.00	30 -15.00
	30 -1.10	(21) +4.00	(9) 0.00	9 -1.00	(24) -10.00
	(15) 0.00	15 +4.00	6 +1.00	6 0.00	9 -6.00
	0 +0.25	0 +0.60	0 +1.00	0 +1.05	0 0.00
	15 +1.00	15 +3.00	10 +2.00	15 +3.20	6 +2.00
	(24) +6.00	(27) +8.00	15 +2.50	(19.8) +3.20	15 +3.30
	30 +11.60	40 +10.00	(28.6) +9.00	30 +6.00	(21) +4.00
			40 +8.50		

NOTE.—The first column is for distances north or south from centre line; the second column is for heights above and depths below formation level; those above to be marked +, and those below —; Slope Stakes to be indicated in the notes, by a circle round the Distance, thus (24), or thus, S.S. 24.

Station. 204	Station. 205	Station. 206	Station. 207	Station. 207+40	Station. 208
1 per 100.	1 per 100.	1 per 100.	1 per 100.	1 per 100.	1 per 100.
390.20	380.00	375.00	377.50	383.00	385.00
392.00	391.00	390.00	389.00	388+60	388.00
.....
1.80	11.00	15.00	11.50	5.60	3.00
<hr/>					
					30 -12.00
45 -18.00	60 -34.00	60 -36	40 -20.00	30 -12.00	(19.5) -7.00
(32.1) -15.40	(48) -26.00	(49.5) -27.00	(33) -16.00	(22.5) -9.00	9 -5.20
9 -9.50	9 -13.00	9 -14.50	9 -12.00	9 -7.00	5 -3.00
<hr/>					
0 -1.80	0 -11.00	0 -15.00	0 -11.50	0 -5.60	0 -3.00
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(9) 0.00	9 -13.40	9 -16.50	9 -16.00	9 -5.00	9 -2.00
20 +1.00	(38) -16.00	(38) -16.00	(30) -14.00	(15) -4.00	(11.1) -1.40
	45 -12.00	45 -14.20	45 -12.00	30 -7.00	20 0.00
					30 +2.00

Section
Book.

20. This Book must be filled up so that it will form a complete and accurate record of all the longitudinal and transverse measurements and levels on each Division or Contract; in the upper portion of each page must be entered in the proper place the chaining to every Station and intermediate point on the Centre line, each change of gradient and the rate of inclination, the height of surface as well as Formation level at each Station and intermediate point, and the depth of Cutting or height of Filling at each Point. The lower part of the page will have every Cross Section regularly entered, giving in each case the distances north and south of the Centre line, and the height above or the depth below formation level. The Slope Stakes will also be designated. Three accurate copies of the Section Book will be required, one for the Division, a second for the District, and a third for the head Office. Each copy must be made from the original notes, and afterwards compared with each other to ensure accuracy; and they must also be properly attested and dated. Tables of Bench Marks and Reference Stakes (see clause 10) must be given at the beginning of each copy of the Section Books.

Attested
Copies.

Plotting
Cross Sect's

21. From these Books the Cross Sections will be plotted on ruled paper, on a scale of 20 feet to an inch, vertical and horizontal, except in special cases, such as rock or other difficult work, when they will be plotted on a scale of 10 feet to an inch on paper ruled to that scale. A blue line to be ruled from top to bottom of the page to denote the centre line.

Slope stakes

22. On these Cross Sections the formation line and slopes will be drawn in red lines, and from these the distances of the slope stakes from the centre line can be ascertained with sufficient accuracy for ground of a tolerably uniform and level surface; but in all cases the position of slope stakes should be verified by the level, and the exact distances so ascertained should be entered in Book No. 3, thus, S.S. 20, or (20).

Ditto.

23. Stakes must also be firmly driven at these points, and the distance distinctly marked on the side facing the centre line, thus, S.S. 30.

Gullet
stakes.

24. In staking out Gulleys for Contractors, the Gullet stakes should be set out for a rock slope of 4

to 1. The Contractor will work to these in the first place, and save himself time and trouble in the event of any of the cuttings turning out rock. Should there be no rock the earth slopes will afterwards be taken out. Should rock occur in part, a berm will be left, as described in the specification. When the rock is laid bare, its surface must be levelled over, and its height at a sufficient number of points, recorded in the Section Books and on the Cross Sections.

Gullies.

25. When it becomes necessary to take earth from borrowing pits, the ground, before it is broken, must be carefully staked out, in squares of from 10 to 30 feet, according to the nature of the surface, the levels taken with reference to the general datum, and the whole particulars entered in the field books.

Borrowing
Pits.

26. In all Cuttings of magnitude strong Plugs about three inches diameter, and say 30 inches long, bound on the upper end with iron, should be driven in the solid ground to formations level at the entrance of the Cuttings, 9 feet distant from, and at right angles to the centre line; the position and level of these Plugs being carefully noted in the field book. These Stakes will be found useful as rough reference and Grade Stakes during the construction of the work.

Grade
Plugs.

27. In preparing plans all *existing objects* as roads, buildings, fences, &c., should be drawn in *black lines*. Water should be indicated by a blue tint. Works *to be constructed* as deviations of Roads and Streams, also the centre line of the Railway and the boundary line of lands required should be shown in *red lines*. In Profiles the surface of the ground should be *black*, and references to *existing* objects, or works such as Roads, Streams, Villages, should be written in *black*. All works *to be constructed* such as Bridges, Culverts, &c., should be shown or written in *red*.

Preparing
Plans and
profiles.

28. Reports will be required periodically, not only from the District Engineers, but from the Division or Contract Engineers, Inspectors and others. It is therefore important that members of the Engineering Staff should keep an Official Diary, entering therein every circumstance connected with the works which may come under their observation. Books will be

Diaries to
be kept.

Reports
and Diaries.

provided for these Diaries, and further instructions given, with regard to the regular reports, which will be required. The object of these Reports and Diaries is to show the progress made from time to time in construction, on every District and Contract, and to place on record accurate information respecting the commencement of structures, the progress and character of all works, as well as the dates, when they were staked out, the force employed, directions given, the weather, difficulties met with and overcome, and every other circumstance relating to the execution of the Railway Works.

SANDFORD FLEMING,
Chief Engineer.

INTERCOLONIAL RAILWAY OFFICE,
Halifax, 25th March, 1869.

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